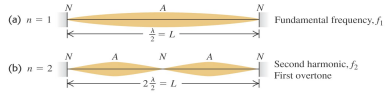
Lecture 7

Standing waves
and
Normal modes

Pre-reading: §16.1

Standing Waves

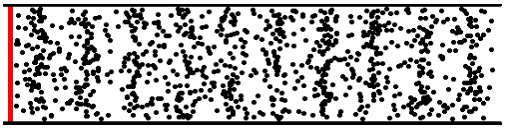
- Formed through reflection + superposition of waves moving in opposite directions
- Contains 'nodes' (no displacement) and 'anti-nodes' (maximum displacement)
- "Normal Mode": property of a system in which all particles move sinusoidally at same freq.
- Lowest freq. normal mode: 'fundamental'
  Higher freq. normal modes: 'harmonics'/'overtones'



§15.8

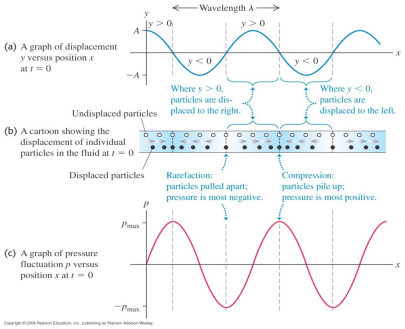
Longitudinal Waves

- Displacement is in direction of wave motion
- Need to distinguish particles from pressure



§16.1

Sound as Pressure Wave

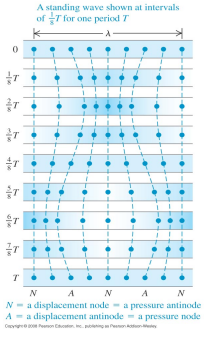


Three ways to describe sound waves

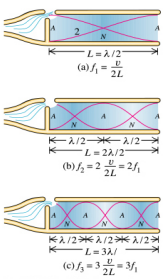
Pressure is 90^0 out of phase with displacement!

Longitudinal Standing Waves

- Waves reflect at open or closed end
- Need to distinguish displacement of particles from pressure
- Node: no displacement
- Anti-node: **Time-averaged** location where max displacement is reached
- Displ. node = Pressure anti-node
  Displ. anti-node = Pressure node

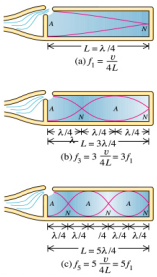


Open pipes



$f_n = nv/(2L)$, n = 1, 2, 3, …

Closed pipes



$f_n = nv/(4L)$, n = 1, 3, 5, …

§16.4

Next lecture

Sound waves
and
Perception of sound

Read §16.1–16.3